

of them five days after operation from necrosis of the wound and sepsis, the other four days after the surgical interference in coma with a hemorrhagic nephritis. The fifth patient was a child of four years, with a large extradural sarcoma which was found to be an extension of a large malignant growth of the right chest. The patient died in shock twenty-four hours after the removal of the growth in the spinal canal. The sixth and seventh patients had high cervical intramedullary tumors. One patient had an intramedullary infiltrating glioma in the upper cervical cord that was an extension downward of a tumor in the posterior cranial fossa. The growth could not be removed and death occurred on the third day from respiratory paralysis. The other patient was a woman with respiratory and cardiac symptoms from a localized intramedullary tumor of the third to fifth cervical segments. This was one of our earliest cases, and after incision of the cord I removed the tumor at the first operation. The patient died from respiratory paralysis two hours after the operation.

A study of these fatalities will show that we have operated upon some patients in whom surgical interference should have been refused; they were operated upon in the beginning of our experience with spinal surgery. It was certainly hopeless to attempt to remove an infiltrating growth, such as in Case VI, or to remove in one stage an intramedullary tumor, as in Case VII. The child with an extension into the spinal canal of a newgrowth in the thorax should not have been operated upon.

The above facts are stated, not with the object of explaining away the mortality rate of 10 per cent. in our operations for spinal cord tumors, but to show that the fatalities after these operations, if the cases are properly selected, should be no larger than 6 per cent. In the future still better results should be obtained.

BRACHIAL BIRTH PALSY: A PSEUDOPARALYSIS OF SHOULDER-JOINT ORIGIN.¹

BY T. TURNER THOMAS, M.D.,
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GENERAL CONSIDERATIONS.

IN 1907 in an adult case of traumatic brachial paralysis with ankylosis of the shoulder-joint following an injury about a year and a half before, breaking up of the ankylosis under ether and the use of forced exercises by the patient resulted in about three months in the return of normal power to the whole limb which

¹ Read before the College of Physicians of Philadelphia, October 1, 1919.

has remained unimpaired since. This has been followed by many similar cases of varying grades of severity, in most of which forced exercises without a preliminary breaking up of the ankylosis under ether sufficed to restore the normal motion to the shoulder and power to the limb. The treatment was so simple and the paralysis usually so fleeting that records were kept of only a small number of special cases. In 1909, in a more severe type of traumatic brachial paralysis, with flail shoulder-joint in an adult, transferred to me at the Philadelphia General Hospital from the service of Dr. J. Chalmers Da Costa, by operation the normal shoulder-joint firmness was restored and by forced exercises the operative stiffness or ankylosis afterward removed. In about four months the patient had a normal arm and has had it since. I have now had 18 similar cases; 12 have been operated on. In 9 the paralysis disappeared and in 2 more it is disappearing. In one case death from lung involvement occurred too early to permit recovery from the paralysis. In 1910, in a boy, aged seven and a half years, with a brachial birth palsy, I found a hitherto undiscovered posterior shoulder subluxation of the same side. A complete paralysis at birth had practically disappeared, a considerable wrist-drop remaining, but the limb was much shortened and crippled from the persistence of the old shoulder-joint displacement. Operative reduction of the dislocation was not completely successful, but the wrist-drop was much improved as well as the function of the whole limb. This was the first time this operation had been done for this condition, but it has already become the prevailing operative treatment for it. I have now had 44 cases of brachial birth palsy and am satisfied that these as well as the above adult cases have been pseudopalsies, due to inclusion of the brachial nerves in an axillary inflammation, consequent upon an injured shoulder-joint and not true paralyzes from injuries of the brachial plexus. Those interested will find a summarized discussion of this whole subject with the associated literature in the *Journal of the American Medical Association*, 1914, ii, 1018. It is not intended here to infer that the paralysis is not real and extensive and that the nerves are not involved, but merely that the paralysis is a pseudoparalysis in the sense that it is only temporary in the great majority of cases. An explanation of the temporary nerve involvement is offered, but even this is not insisted on. It is merely supported until somebody else offers a better explanation. What is insisted on, however, is that the primary and essential cause of the trouble in most cases is in the shoulder-joint, and that when that is removed early enough we need not be much concerned about the paralysis. That will then take care of itself. What we need most in the obstetrical cases is skilful attention to the shoulder at birth by the accoucheur, but we are probably a long way from this now.

It is manifestly impossible for this new and radical view to make headway without controversy against the universally accepted contrary theory, that of injury to the brachial plexus. The recent work of J. J. Thomas and J. W. Sever, in support of the plexus theory, directly challenges the shoulder-joint origin. They published the results of their work in three papers, all covering essentially the same ground, to which I shall refer when necessary, for the sake of brevity, as the orthopedic,¹ pediatric² and neurological³ papers. The object of their work is seen in the following (pediatric): "Up to within a year or so most of us were reasonably content to accept the theory that the paralysis in these (obstetrical) cases was due to a stretching or tearing of some of the roots of the brachial plexus, due to a forcible separation of the head and shoulders during labor. Other theories have been discussed and have been given some credence, but recently a new one has appeared. It seems that it is about time for us to take account of stock and see which of these various ideas which have been advanced are reasonable and based on pathological findings, and clinical facts." Their essential conclusion is as follows: "There is no evidence from our experimental work or clinical observations to support the theories of Lange and T. Turner Thomas that the primary cause of obstetrical paralysis lies in an injury of the capsule of the shoulder or dislocation, with secondary damage to the nerve trunks."⁴ They admit that a few cases of shoulder-joint origin may simulate obstetrical paralyses, but claim that these are readily distinguishable.

When it was decided that I would assume the responsibility of opposing the then universally accepted plexus rupture theory and attempt to substitute a shoulder-joint origin, there was no reason to suspect it would soon be necessary to maintain priority for this view. In this connection it now becomes necessary to point out a certain confusion of facts, particularly in the papers signed by Sever alone. I am credited with only one paper, and this is given two dates of publication, 1913 and 1914. Lange's single paper is credited to 1912 and 1913. Notwithstanding these dates, Sever says: "T. T. Thomas has fallen back on the old Lange theory that the injury to the plexus is secondary to an injury to the joint capsule at birth and that the paralysis is due to an exudate which surrounds and compresses the plexus." In the neurological paper, signed by Thomas and Sever, I am credited with six papers and am here given credit for priority over Lange by two years, my first paper being dated 1910 (it was read in 1910) and Lange's 1912, and yet the following statement appears in this paper: "T.

¹ Sever: *Am. Jour. Orthop. Surg.*, 1916, xiv, No. 3.

² Sever: *Am. Jour. Dis. Child.*, 1916, xii, 541.

³ Thomas and Sever: *Jour. Nerv. and Ment. Dis.*, 1916, xlv, 289.

⁴ Thomas and Sever: *Jour. Am. Med. Assn.*, 1916, i, 206.

Turner Thomas was, perhaps, the first advocate of this theory in this country." I would state the facts as follows: The first mention in the literature of the shoulder-joint origin of traumatic brachial paralyses in adults and in children at birth and the first suggestion that the basic primary lesion was a laceration of the joint capsule appeared in my paper of the January, 1911, issue of the *Annals of Surgery*, while this is my sixth paper on the subject. Lange's first and only paper on obstetrical paralysis appeared in the latter part of June, 1912.

The few writers who have taken up the Klumpke,⁵ lower arm, type of traumatic brachial paralysis in support of the Duchenne-Erb, upper arm, type have added to the difficulties in the solution of an already troublesome problem. There is distinct evidence that most of them have not studied Klumpke's paper. The general tendency has been to avoid this phase of the subject, and with good reason. Madame Klumpke did not report any personal experience with obstetrical paralysis, but referred to two cases reported by Seeligmüller. Her paper was based on one personal adult case of total, flaccid, brachial paralysis of motion and sensation together with a collection of similar cases from the literature. A sharp distinction should be made between this and the Duchenne-Erb type of paralysis. Klumpke saw the difference which must impress anyone who will study the two groups of cases. In the Duchenne-Erb there is essentially no disturbance of sensation, although all cords of the brachial plexus are mixed motor and sensory nerves; the paralysis of motion gradually disappears completely except occasionally for some atrophy and weakness, due to a severe restriction of motion at the shoulder-joint, sometimes at the elbow; and there is a practically constant but varying grade of such joint ankylosis. Klumpke's case was an adult and the cases she collected from the literature like it were adults. Note how the condition she found in her own case differs from that found in the Duchenne-Erb type: Sensation is completely and permanently lost except for some variation in its upper limiting border; the paralysis of motion is likewise complete and permanent; and there is no report of ankylosis at the shoulder. The Duchenne-Erb is a temporary or pseudoparalysis, the Klumpke a permanent or true paralysis. Klumpke's chief interest and study was in connection with oculomotor phenomena, particularly inequality of the pupils, and it was because of similar phenomena in Seeligmüller's two cases that she included them with her adult cases. Inequality of the pupils has not been reported often in connection with obstetrical paralysis and not with much positiveness and detail when it has been. I cannot say that it has attracted my attention in any of my cases. I have observed asymmetry of the face but have attrib-

⁵ Rev. de méd., 1885, v, 591 and 739.

uted it to a sympathetic or associated atrophy on the side of the brachial paralysis. I have seen the same side of the chest much atrophied as well as the face.

The fact that in the great majority of obstetrical paralyses the paralysis gradually disappears until it cannot be recognized explains why reports of the condition in adults are so rare. I have never seen such a report, but I have seen two cases of rather a severe grade in adults. One was an orthopedic surgeon who very kindly called on me and gave me the privilege of examining the arm. He had a posterior subluxation of the shoulder-joint; a marked bending downward and forward of the acromion, which was shown well by the roentgen ray; and still had a considerable limitation of movement in this joint. He said the condition had been much more severe in his younger years, but there was at the time I saw him no evidence of paralysis. In addition to the absence of paralysis he furnished another good reason why we do not recognize the condition in adults. He could not afford to permit his present and prospective patients to know that he was crippled and unable to help himself. He added, also, that, so far as he knew, none of his patients or colleagues ever suspected the condition. The second case was a pupil nurse who seemed to have no trouble in performing her duties. She had no paralysis but had some atrophy from the limitation of movement at the shoulder.

SUPPORT FOR THE SHOULDER-JOINT PATHOLOGY. The temporary or pseudoparalysis, the practically constant preservation of sensation and the practically constant limitation of shoulder movement, which seems to be readily accounted for by the compression of the shoulder by the maternal pelvis during delivery, led me to suggest that the joint injury was primary and the paralysis secondary to it from inclusion of the branches of the brachial plexus in the axillary inflammation consequent upon the joint injury. A non-traumatic inflammation of the joint could produce a similar result. Since I never considered it justifiable to expose the nerves in any of my cases I have been compelled to offer the postmortem and operative evidence of others. Delbet and Cauchoix⁶ collected 33 cases from the literature of brachial paralysis in adults following dislocation of the shoulder and added 2 of their own, in which the nerves were exposed at autopsy or operation, usually in the axilla. No rupture was found, but the nerves were embedded in cicatricial tissue, inflammatory tissue or bloody extravasation. Lange⁷ exposed the axillary nerves in a case of obstetrical paralysis and found the cause of the paralysis to be the embedding of the nerves in dense connective tissue for an extent of about 4 cm. In 81 cases of obstetrical paralysis in which the brachial plexus was exposed,

⁶ *Rev. de chir.*, 1910, xxx, 673.

⁷ *München. med. Wehnschr.*, June, 1912, No. 26.

Wyeth and Sharp⁸ found that the "usual lesion was a dense connective-tissue formation choking the plexus and thus impairing its function." Most others who have operated on the plexus in obstetrical paralysis have interpreted these cicatricial conditions as being due to rupture of the brachial plexus. Ashhurst⁹ says: "The descriptions of what has been found at operation soon after birth are so vague that not much reliance can be placed on such observations; this vagueness probably is due to the impossibility of telling, even with the nerves exposed to view, how much they were damaged. In cases operated on months or years after the injury occurred the extent of the scar tissue and the difficulty of the dissections render such observations also of limited value." Eversmann¹⁰ reported the autopsy findings in a case two and half months after birth. The only lesion discovered was an induration, with thickening at the junction of the fifth and sixth cervical roots of the brachial plexus, for $\frac{1}{2}$ to $\frac{3}{4}$ cm. One could hardly accept these findings as proving a nerve rupture, although they have been widely quoted to prove such an injury.

Stransky¹¹ quotes Rouland as reporting an autopsy on a case of obstetrical paralysis which died on the tenth day. The nerve findings were negative. It is probable there is not a case of obstetrical paralysis on record in which a frank, recent rupture of any of the cords of the brachial plexus has been found at operation or autopsy. Probably the only case on record with an autopsy soon after birth showing evidence of injury is that of Danyau,¹² who did not find nerve rupture but bloody extravasation around the plexus. He regarded it as evidence of injury of the plexus by forceps, and most of the writers who have since quoted the case agreed with him. Seeligmüller,¹³ who was contemporary with Danyau, Duchenne and Erb, and one of the most quoted writers on this subject, thought that the bloody extravasation came from injury of the surrounding tissue by the forceps. He quotes the findings by Fritsch in autopsies on children born by the breech of bloody extravasations under the skin and in the muscles. He believed with Fritsch that such blood could alone cause paralysis by pressure on the nerves, so that with the disappearance of the blood the paralysis would disappear. Fritsch found in one case two days after a difficult delivery of the head a 5 cm. wide hematoma near the lower end of the sternomastoid, the disappearance of which was followed by disappearance of a paralysis of the corresponding arm.

⁸ Surg., Gynec. and Obst., 1917, xxiv, 34.

⁹ Ann. Surg., 1917, lxviii, 25.

¹⁰ Arch. f. Gynec., lxviii, p. 143.

¹¹ Centralbl. f. d. Grenzgeb. d. Med. u. Chir., 1902, v.

¹² See Duchenne, l'Electrisation, 1872, pp. 353-357.

¹³ Berl. klin. Wehnschr., 1874, p. 510.

SEVER'S CAPSULE INJECTIONS AND THE DUCHENNE-ERB THEORY.

The suggestion that the paralysis is due to inclusion of some or all the branches of the brachial plexus in the axillary inflammation consequent upon a shoulder-joint injury is combated by Sever as follows (pediatric): He injected the shoulder-joint of several newborn infant cadavers with methylene-blue and then made an opening in the anterior part of the capsule of the joint to prove that the exudate following a dislocation or sprain of the shoulder-joint would not extend to the brachial plexus above the clavicle. In answer to this I would merely say that if the ecchymosis and exudate from a dislocation of the shoulder-joint, as not infrequently happens, extravasates to the elbow and hand, it will surely go a few inches above the joint to the brachial plexus, particularly in a newborn infant occupying generally the recumbent position. A discussion of the following quotation from Sever could be of very much importance, because it concerns the most vital part of the whole question. "This (the surrounding and invasion of the axillary nerves by the methylene-blue) would in life lead to a paralysis of the whole arm at and below the joint (shoulder), but would in no way affect the nerves above the clavicle, and in no case would there be the typical picture of obstetrical paralysis, *i. e.*, paralysis of the fifth and sixth cervical. As I have stated before, why the exudate should leave the nerves alone in immediate proximity of the capsule and seek out Erb's point, the junction of the fifth and sixth cervical segments, at least two or three inches above the clavicle, Lange and Thomas and others have not made quite clear." The emphasis here should be laid on the fact that Sever accepts without reserve the localization of the lesion at Erb's point. Such unreserved acceptance is very rare in the literature, today, although a few years ago it was almost universal. In a discussion of this subject with an eminent surgical friend in the spring of 1914, he said: "Am I to understand that you do not accept the C V and C VI (Erb) theory?" On my replying in the affirmative he said: "I am amazed! I did not think that anyone doubted that." So far as the literature shows, that was the attitude of probably the whole profession a short time before, but it (Erb theory) has lost a few supporters since.

The amazing thing is that so many writers have accepted and so few have proved it. What is this Duchenne-Erb idea and upon what kind of evidence does it rest? Duchenne,¹⁴ in four infants a few weeks old, localized the paralysis by *electrical reactions* in every case, without exception, to the deltoid, biceps, brachialis anticus and infraspinatus. This was in 1872. Erb,¹⁵ in 1874, in four adults, localized the paralysis by electrical reactions without

¹⁴ Loc. cit.

¹⁵ Naturhistorisch. medicin. Verein zu Heidelberg, 1874, No. 1, 130.

exception to the deltoid, brachialis anticus and biceps, usually to the supinator longus and sometimes to the supinator brevis, in one case to the supply of the median in the forearm and hand. In one case of obstetrical paralysis, two months old, he found that "The exact observation, which naturally gave considerable difficulty, showed that the deltoid, biceps, brachialis anticus (probably also the supinator longus), were completely paralyzed and that the infraspinatus was also probably paralyzed." Erb's particular contribution consisted in the fact that he localized the lesion to the junction of the fifth and sixth cervical roots of the plexus. We are confronted at once with the difficulty that the two differed in their localization of the paralysis, but this does not seem to have attracted particular attention. The most characteristic feature of the paralysis is the internal rotation. It is of interest that Duchenne accounted for the internal rotation from the shoulder down and Erb from the elbow down, Duchenne attributing it to paralysis of the infraspinatus and Erb to paralysis of the supinators of the forearm. Obviously the only way by which their work can be corroborated is by finding the same specially localized paralysis in the same way as they did—by *electrical examination*. There can be no substitute for this evidence. To what extent has this been done since the reports of Duchenne and Erb forty-seven and forty-five years ago? A satisfactory answer to this very important question would probably be impossible because of the very extensive literature that has accumulated and the difficulty of avoiding errors in searching it. Thomas and Sever collected the literature since 1902 and referred to that collected by Stransky up to that time, in this way covering the whole ground. All of this literature has been scanned with the purpose of finding cases in which the electrical reactions obtained by Duchenne and Erb were confirmed. While one hesitates to give the results because of the possibilities of error and the impossibility of gaining access to some papers, particularly to the theses, a strong suspicion was developed that no matter how careful the investigation very few such cases can be found. Gowers,¹⁶ in 1888, in a clinical lecture referred to a case of obstetrical paralysis examined before the same class a few weeks before in which the electrical reactions characteristic of degeneration had been found in the deltoid, biceps and supinator longus. This is the closest corroboration of Duchenne and Erb that I succeeded in finding, and here there is no mention of the brachialis anticus which was included by Duchenne and Erb. Shoemaker¹⁷ is one of the most quoted supporters of this theory. In the first of his two cases, in the first few days, the right arm hung in internal rotation, motionless except for slight extension and

¹⁶ *Lancet*, April 14, 1888, p. 709.

¹⁷ *Ztschr. f. Geburtshilfe und Gynäk.*, 1899, xli, 33.

flexion of the fingers. In four to six weeks the power of the other muscles had so improved that a pure Duchenne paralysis had developed which was characterized by involvement of the supra- and infraspinatus, deltoid, biceps and supinators. His interpretation of a "pure" case is evidently open to question. Nor did he make any mention of the use of electricity. Of his second case he said "exact examination shows that the following muscles exhibit delayed development: supra- and infraspinatus, deltoid, biceps, triceps and supinators," surely not a pure case. He quotes Roulland (*Thèse de Paris*, 1887) as reporting a case spontaneously born with a typical Duchenne-Erb palsy (supra- and infraspinatus, deltoid, triceps and brachialis anticus). Here there is no reference to electrical reactions nor to palsy of the biceps, while the supra-spinatus and triceps, not mentioned by Duchenne or Erb, are included in the paralysis. Hochsteter,¹⁸ in 1893, reported a case in which "electrical examination by Goldscheider at the end of the third day showed no response of the nerves on both sides, to the constant or indirect current, on the other hand the arm muscles on the paralyzed as on the sound side were brought directly to contraction by both currents." These few cases represent merely a crude effort to turn light on a phase of this discussion that much needs it, and if it results in similar efforts by others it will have served its chief purpose. Unless someone else can do better than this we must assume that the findings of Duchenne in four cases and Erb in one case of obstetrical paralysis represent the only scientific evidence upon which the Duchenne-Erb etiology for this condition is resting today, *i. e.*, the originators of the theory have not been corroborated.

The number of cases reported has increased rapidly in the last few years, but those in which the electrical findings are reported still remain conspicuous by their absence. The failure to find such cases in the literature is strongly corroborated by the following: Fairbanks, in 1913, reported a personal experience of 40 cases, probably the largest up to that time, and supported the brachial plexus theory. He said that electrical examinations are not necessary before the end of the second month, the use of an anesthetic being essential; but by this time the case will probably show definite signs of recovery, so as to render electrical examination unnecessary. Thomas and Sever report a personal experience of 471 cases, by far the largest up to the present, and, perhaps, as large as that of all other writers put together. Sever says of these cases "electrical reactions have not been carried out, for this examination would mean anesthesia, which did not seem justifiable when one already had all the necessary data." We are looking now for corroboration of Duchenne and Erb, and we have here

¹⁸ Berl. klin. Wehnschr., 1893, xxx, 1016.

what amounts practically to a confession that it is not obtainable. There is nothing in the articles of Duchenne and Erb to indicate that they found anesthesia necessary for their electrical examinations. Why should it be necessary for ours? Does this not indicate something radically wrong with their method of electrical examination or with ours? Of what value is it to us that Duchenne forty-seven years ago in four cases, and Erb, forty-five years ago in one case, found these electrical reactions if we cannot find them in any of our hundreds of cases today? It seems to me that those who accept the Duchenne-Erb theory carry a heavier responsibility than those who reject it.

If one may judge from the apparent lack of familiarity of most writers on the subject with the original articles of Duchenne and Erb and the difficulty I experienced in gaining access to them, very few have consulted them. This probably has had something to do with the widespread and unchanging faith that has grown up around them. There has been too much agreement with and dependence on what they found. Sever says that the results of his methylene-blue injections into the shoulder-joint indicated that in life we should have "a paralysis of the whole arm at and below the joint (shoulder)," but that we do have instead a localized paralysis of the Duchenne-Erb type. My experience has led me to the reverse opinion, that we do have the kind of paralysis suggested by Sever's experiments, soon after birth, and do not have the Duchenne-Erb localization, soon after birth or at any other time. I saw 5 cases within eight weeks after birth. One of the 5 had, at six weeks, made a rapid recovery and was moving all parts of the limb, although not normally. Later it made a complete recovery. Dr. L. C. Peter, a neurologist, saw the patient soon after birth and then found a complete paralysis except for slight movements of the fingers. In 1 case seen five days after birth there was not observed a single movement in the whole limb, not the slightest in any of the fingers, but occasionally the child would move the limb as a whole at the shoulder. In the other 4 cases there were very slight movements of the fingers, but of no other part of the limb. These findings are in perfect accord with the results of Sever's experiments.

ERB'S LOCALIZATION. Probably the most striking features of Erb's paper are its positiveness and the dogmatic character of its clinical findings and conclusions, which allow little else to the reader than to accept or reject them. The result has been so one-sided that one will probably look in vain for any attempt at question concerning them. His localization of the lesion to the junction of the fifth and sixth cervical roots of the brachial plexus is based essentially on his findings by electrical examination in the four adult cases. His one obstetrical case was evidently employed to show that this special localization discovered by Duchenne in

his obstetrical cases was the same as in his (Erb's), adult cases, so that one wonders how the modern supporter of the Erb C V and C VI theory can accept this special localization for the obstetrical cases without accounting for the adult cases in present-day practice. For many years it was accepted for the adult cases, but one looks almost in vain today for any mention in text-books or the literature of this condition in adults. So far as it has been corroborated by electrical examinations in adults it has never had a strong position, according to my investigations. Taylor and Casamajor (*Annals of Surgery*, November, 1913, p. 577) reported 6 adult cases in connection with 4 of which very incomplete electrical reactions were given. They do not corroborate Erb's or Duchenne's findings. Remak¹⁹ in 1877, Hoedemaker²⁰ in 1878-1879, Bernhardt²¹ in 1882 and Nonne²² in 1887 reported cases in which they found this specially localized paralysis of Erb by electrical examination, but the localization was far from being as precise as in Erb's original paper. It is of some interest to note that Remak was a pupil of Erb, that one of Hoedemaker's 2 cases occurred in the private practice of Erb and that Erb made the electrical examination in Nonne's one case. I found only one other adult case reported in which a similar paralysis was established by electrical examination, but the report was so brief and casual that one hesitates to use it as corroboration. In my opinion Erb's paper is open to at least one serious criticism. He localizes the lesion to the junction of the fifth and sixth cervical roots of the plexus. The fibers to many other than his paralyzed muscles pass through this junction, but he says that "In all four (adult) cases, without exception," the lesion involves the fibers to the same four or five muscles, all the other fibers escaping every time. Now in Case I he accounts for this particularly localized lesion by a traumatic neuritis of the brachial plexus from carrying a heavy load on the head. In Case II, he accounts for the same lesion by a "traumatic lesion of a part of the brachial plexus" from a fall down stairs on the outstretched left hand and simultaneously striking with the left shoulder against a wall. In Case III he accounts for it by a "neuritis of a certain portion of the brachial plexus" of unknown cause. In Case IV we are told that a cancerous involvement of the supraclavicular lymph nodes, the patient dying in a few weeks from carcinomatosis, produced pressure on the brachial plexus only at Erb's point. It does not seem to me that such a precise localization of the lesion would be accepted today on such evidence.

Every surgeon knows there is a large number of cases of weakness or palsy of the arm following injury of the shoulder, the

¹⁹ Remak: Berl. klin. Wchnschr., 1877, xiv, 116.

²⁰ Arch. f. Psychiat. u. Nervenkrankh., 1878-9, ix, 738.

²¹ Ztschr. f. klin. Med., 1882, iv, 415.

²² Deut. Arch. f. klin. Med., 1887, xl, 62.

pathology of which has never been satisfactorily established. Some see them as paralyses, others only as stiff and painful shoulders of uncertain cause. It is generally understood that dislocations of the shoulder are frequently associated with the severe cases. It is very likely that the Duchenne-Erb type of paralysis resulted from one of the efforts to solve the problem involved. Schulz,²³ in 1908, reported a study of the late results in fifty-four uncomplicated dislocations of the shoulder and found varying grades of brachial palsy in 75 per cent. of them, and in most of the others there was some diminution of strength. He accounted for them by cicatricial contraction of the joint capsule and surrounding tissues. The outstanding fact in connection with these cases is that there was no nerve complication in any at the time of the dislocation. In the July number of *Surgery, Gynecology and Obstetrics* there is an abstract of a paper by Korteweg²⁴ on "The Results of Dislocation of the Shoulder and its After-treatment." He reviewed 845 cases. The abstract says: "For the diagnosis of a nerve paralysis the author demands the presence of disturbances of sensation and the complete or partial reaction of degeneration." We can only infer that "nerve paralysis" applies here to paralyses due to nerve injury and that Korteweg must have found some that were not in this class. I believe that his diagnostic rule will some day be applied to the obstetrical paralyses by the profession generally and that the Duchenne-Erb theory will fail to withstand the test.

PROGRESS OF SHOULDER-JOINT THEORY. Attention has already been called to the support which the pathology of a shoulder-joint injury in its etiological relationship to these cases has obtained in the literature. The theory of a shoulder origin has gained rapidly in the last few years, and it has had occasional support from the beginning. In his first article (1861) Duchenne attributed obstetrical paralysis chiefly to the associated posterior subluxation which he believed occurred at birth (see Fig. 1). Injury of the brachial plexus also contributed to the paralysis in his opinion. In his second article (1872) he reported 4 cases without dislocation in which he attributed the paralysis entirely to injury of the plexus. The profession afterward practically ignored the dislocations for many years, and during the last fifteen years, when they have been forced upon the attention of the profession again, the supporters of the plexus theory have accounted for them as a secondary development of the paralysis from the plexus injury. Erb, who reported only 1 case of obstetrical paralysis, thought careful examination would show the dislocations to be few in number. Seeligmüller says that these paralyses in the newborn are frequently complicated by fractures and dislocations and that these compli-

²³ Deutsch. Ztschr. f. Chir., 1908, ix, 333.

²⁴ Zentralbl. f. Chir., No. 46, p. 926.

cations have been completely overlooked in many cases. He saw 1 case with an undoubted dislocation of the humeral head into the infraspinous fossa. He says that Smellie (who was the first to report obstetrical paralysis in 1768) reported several cases of persisting arm paralysis, due to dislocation *intrapartum*. Dauchez²⁵ recognized "obstetrical pseudoparalysis," in which paralysis is simulated by a unilateral or bilateral dislocation of the upper extremity. Küstner,²⁶ in 1889, attracted much attention by his

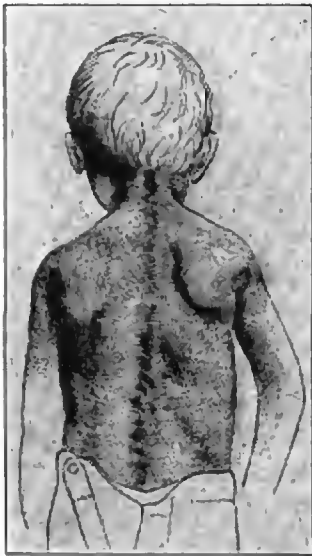


FIG. 1



FIG. 2

FIG. 1.—Duchenne's illustration of his case of obstetrical paralysis with posterior subluxation of the shoulder-joint. The associated paralysis was attributed chiefly to the dislocation which was accounted for by the manipulations of the accoucheur at birth.

FIG. 2.—One of the author's cases with a severe degree of posterior subluxation of the shoulder-joint. The prominence of the humeral head is about as noticeable and there is the same internal rotation of the whole limb and flexion of the elbow, and almost the same prominence of the angle of the scapula, as in Duchenne's case (Fig. 1) The plexus theory supporters, today, say the dislocation is secondary to the paralysis from injury to the plexus.

contention that these obstetrical paralyses were due to injuries of the upper epiphysis of the humerus and the German surgeons who today find the same lesion are probably influenced by his work. The roentgen ray in those cases in which ossification has advanced far enough prove conclusively that the deformity is due to dislocation, not to displacement of a separated epiphysis. B. Sachs²⁷ said, in

²⁵ *Ann. de Gynecol.*, 1891, xxxvi, 300.

²⁶ *Handbuch der Geburtshilfe*, p. 301.

²⁷ *Jour. Nerv. and Ment. Dis.*, 1904, xxxi, 670.

1904: "If many cases were examined soon after birth there might be found a distinct subluxation of the head of the humerus, probably below the deltoid, which might possibly be identified with Erb's palsy; therefore, all cases of obstetrical palsy were not Erb's palsies." Whitman, in a personal communication in 1914, recognized in addition to the common cases with posterior luxations of the shoulder: (1) True congenital luxations of the shoulder (rare); (2) obstetrical luxations at birth usually with paralysis;



FIG. 3.—Obstetrical paralysis without dislocation, five days after birth. Not the slightest power in any of the muscles of the limb. Today, there is clearly power in all the muscles and the patient elevates the whole limb forward to the level of the shoulder.

(3) fractures of the humerus at birth at any point, rarely with displacement of the epiphysis of the head (may or may not be accompanied by paralysis); (4) in a large proportion of the ordinary cases of obstetrical paralysis there are evidences of injury of the shoulder of the nature of strains or sprains, as shown by sensitiveness to movement and pressure. Lange, in 1912, said that most of the obstetrical paralyses were due to lacerations of the capsule of the shoulder-joint. Platt,²⁸ in 1915, favored the plexus theory for

²⁸ British Med. Jour., May 8, 1915, p. 793.

most cases, a primary injury of the shoulder-joint or upper humeral epiphysis for some cases, but treated only the shoulder ankylosis which he found in all cases. Vulpius,²⁹ in 1914, ascribed these cases to epiphyseal injuries and found by exact examination that there was no real paralysis or, at least, it was not at all prominent. Gaugele,³⁰ in 1914, said that most cases were pseudopalsies, due to distortions of the shoulder-joint, with injuries of the capsule and other soft tissues and confined his treatment to the shoulder-joint. Peltsohn,³¹ in 1914, said that most obstetrical paralyses are due not to injuries of the brachial plexus, but injuries of the upper humeral epiphysis. Van Neck,³² in 1912, said that tears of the shoulder capsule and injuries of the upper epiphysis of the humerus simulate obstetrical paralysis. G. G. Davis,³³ in 1916, said that "there is primarily an injury of both nerves and articular structures." He also said: "The restriction of external rotation of the humerus is marked in these infants only a few weeks old," and that "The presence of restriction of movements a few weeks after birth is proof positive of periartritic lesions." His treatment is confined to the restriction of movement at the shoulder-joint, the elbow-joint and forearm requiring attention in some cases. Ashhurst says: "All the muscles most constantly paralyzed are supplied by nerves which pass very close to the shoulder-joint, and, *ipso facto*, are liable to injury; whereas the muscles which habitually escape paralysis are supplied by nerves which at no part of their course come into close relation with the shoulder-joint or the bones which compose it. This seems to bring us very close to the theory of Thomas and Lange that the primary lesion is in the shoulder-joint and that involvement of the nerves occurs secondarily. It is indeed a question in my own mind whether this is not the most acceptable theory for the majority of cases."

CADAVER EXPERIMENTS ON THE BRACHIAL PLEXUS. In the last analysis the Duchenne-Erb theory must rest upon corroboration and the only kind of corroboration that will avail will be to find in our cases what they found in theirs, the proof of the definitely localized paralysis by electrical examinations. What are the other "necessary data" upon which Sever depended? That resting upon the interpretation months or years after birth of the adhesions and nerve thickenings found at operation or autopsy and the experimental data. The operative and postmortem evidence has been disposed of in the discussion of the pathology of the shoulder injury, and I would again refer particularly to the quotation from Ashhurst, with which I fully agree.

²⁹ Deutsch. med. Wchnschr., 1914, xl, 1053.

³⁰ Ztschr. f. Orthop. Chir., 1914, xxxiv, 511.

³¹ Berl. klin. Wchnschr., 1914, li, 1162.

³² Jour. de Brux., 1912, xvii, 117.

³³ Internat. Clinics, vol. iii, series 26.

The experimental work has played a great part in supporting the Duchenne-Erb view. Fieux,³⁴ by lateral bending of the neck in the cadaver produced tearing of the roots of the brachial plexus most marked in those arising highest in the neck. He also produced a paralysis of the upper extremity in a rabbit by lateral bending of the neck. Shoemaker, after exposing the brachial plexus, like Fieux, in the cadaver of a newborn, prepared by alcohol, could not produce a tear of the plexus, but accepted the results and conclusions of Fieux for most of his cases. Taylor³⁵ made twenty dissections on ten infants within three to ten days after death. He found that tension was the only factor concerned in the production of the plexus lesion responsible for Erb's paralysis. By tension he produced a rupture at or about the junction of the fifth and sixth cervical roots of the plexus, in the twenty plexuses, *i. e.*, on both sides of the ten infants. He says "great force must be employed to cause the lesion." Sever's experiments consisted in applying traction and forcible separation of the head and shoulder in "numerous dissections on infantile cadavers." It is a little difficult to determine the results of the force applied, but one obtains the impression from his statements that with forcible separation of the head and shoulders, without lateral bending of the neck, the cords of the plexus could not be ruptured, but were made to "undergo dangerous tension and stand out like violin strings." He goes on to say that: "With the shoulder held and the head carried to one side, with the clavicle intact, considerable force was necessary to injure the plexus," and that "Even with considerable force the fifth and sixth nerves could not be completely torn across at Erb's point but frayed out inside the sheath, which always gave way first." With the clavicle removed it was easier to injure the plexus, but the clavicle is practically never broken in these cases, so that this experiment does not concern the problem at hand.

It is evident from the preceding experiments that much force is necessary for the production of a tear of the plexus by traction in the cadaver. In looking for a similar force during the delivery of a child we must keep in mind that forceps traction cannot be exerted on the brachial plexus because such traction can occur only after the head is delivered when the forceps are put aside. In most deliveries when the head is out the shoulders soon follow without much traction, often without any. Indeed, one will have no difficulty in finding cases in the literature of obstetrical paralysis developing after spontaneous birth. A case of this kind, reported by Roulland, has been mentioned on a preceding page. Labor was normal in 32 of the 471 cases reported by Thomas and

³⁴ Ann. de Gynec., xlvii, 52.

³⁵ AM. JOUR. MED. SC., October, 1905, p. 675.

Sever. In view of the results of the above experiments, particularly those of recent years, it is hardly conceivable that the mild lateral bending of the neck necessary for the delivery of an occasional obstructed shoulder will be sufficient to tear the brachial plexus.

I have tried the effect of direct extension on the head and lateral bending of the neck in six bodies of newborn infants, for which the following manipulations and results will be sufficiently representative to answer for all. Placing the body face downward approximately in the L O A position I applied the ordinary forceps (obstetrical) to the head, and while an assistant made counterextension on the shoulders, with my feet braced on the floor I pulled as hard as I could on the forceps—harder, I believe, than any competent physician ever pulled in a successful delivery. This was repeated two or three times. Then placing the right side of the neck on a suitable block of wood, with one hand on the head and the other on the shoulder, I bent the neck over the block with all of my force. This maneuver was repeated twice, after resting between the efforts. I then went through the same procedures on the opposite side of the neck. Dissection of the plexus on both sides showed no visible rupture at any point in either plexus. With the plexuses dissected clean of all traces of their sheaths the direct traction and the lateral bending on both sides were repeated with the same force as before while watching the plexus of each side in turn for any evidence of rupture, but none was detected. It may be well to bear in mind that as the traction is being applied to the neck and plexuses the continuations of the plexuses, the nerves, are surrounded by loose connective tissue and offer little resistance to the traction. If the dead nerves withstand such traction live ones are more likely to do so.

TREATMENT. The length of the preceding discussion concerning the etiology is worth while only if it leads to a more simple and effective method of treatment. Efficiency is the order of the day and obsolete ideas and methods are being ruthlessly set aside. One will have difficulty in showing any real progress in the treatment of these cases based upon the pathology of a plexus rupture. Lange spoke of it as the "let alone treatment." The rapidity with which the shoulder-joint treatment has been taken up by the profession since it was based upon a shoulder-joint origin of the condition, indicates that the theory of a brachial plexus origin is being rapidly set aside as surely as the same theory for the adult cases has long been obsolete. While practically all surgeons interested in the condition have adopted the shoulder-joint treatment the acceptance of the shoulder-joint origin has not been so general. Platt, perhaps, best expresses the mental attitude of most surgeons when he says: "As the treatment (of shoulder) is the same for all, the diagnostic disability (as to the seat of the causal lesion) is happily not of great

importance." As an indication of the rapidity and completeness with which the shoulder treatment is being recognized this is very satisfactory. But it is not enough because it is not all that the theory of a shoulder-joint origin offers. The shoulder-joint is injured at birth or it is not. If it is injured at birth that is the time to correct the damage, not many years afterward, nor many months or days. If there is no displacement in the joint, complete recovery will probably follow sooner or later, without special treatment; but if there is a displacement, and this is permitted to "heal in" for a few weeks, the chances are that nothing short of operation will restore the joint to the normal. If the correction is delayed a year the chances are that the normal joint relation cannot be restored even by operation. Sever says that the mere division of the sub-scapularis tendon is followed by the reduction of the dislocation. Much depends upon what we consider reduction. I have made persistent efforts at reduction in my earlier cases but with little success so far as actual change in the relations of the humerus and acromion are concerned. I am inclined to agree with G. G. Davis, that the good results of the operation are "due not to replacement of the head of the humerus but to the free division of restraining tissues and the placing of the parts in a better position."

We shall not obtain the best results, in my opinion, until we appreciate what went wrong at birth and make our efforts to correct it then. The only way in which this can be demonstrated is by the results in cases so treated. It is probably impossible to determine exactly what happens to the shoulder, but I believe one can obtain a crude but still effective conception of the mechanism of the shoulder injury from a close study of the typical deformity itself. In my judgment only one conceivable cause can account for this deformity, and this will account for every feature of it. The part of the child most liable to damage as it comes through the bony maternal pelvic ring is the widest part, at the shoulders. In rare instances Nature has not provided enough room, and one shoulder, probably the anterior, is jammed out of shape as it is passing under the pubic arch, temporarily or permanently according to the degree of compression. In either case there is a severe brachial paralysis from involvement of the axillary nerves in the consequent axillary inflammation, and the shoulder-joint soon becomes stiffened from the resulting cicatricial contraction. But the inflammation subsides and the cicatricial tissue is absorbed, so that the paralysis gradually disappears, the permanent crippling being due to permanent injury to the shoulder-joint. The elbow suffers often in less degree, but this phase of the subject is left out of the discussion now because it confuses the more important phase.

The shoulder deformity has always been the same in my cases except as to degree. It has three very important characteristics:

internal rotation of the humeral head and therefore of the whole limb, mild posterior displacement of the humeral head and bending downward over the head of the acromion antero-externally. The internal rotation is obvious, but the other two characteristics have not received attention until recent years because of their obscurity. They will probably continue to be overlooked in many cases. It may be almost impossible soon after birth to decide the question. There is one pathognomonic sign of the subluxation: On the normal side the upper end of the humerus projects a variable distance in front of the anterior edge of the acromion. On the side of the subluxation it cannot be felt from in front and by careful palpation with the finger the anterior edge of the acromion can be located a considerable distance below its normal level. On the normal side there is a hollow under the posterior border of the acromion; on the affected side, a prominence. The same pressure which forced the head backward bent the acromion down in front of it. It is this bent acromion in front of the humeral head that accounts for the permanency of such a mild subluxation, *i. e.*, permits the head to rest on the posterior glenoid margin without slipping back into the glenoid cavity. It is likely that the cases of obstetrical paralysis without subluxation are those in which the head was not pushed backward enough to allow the acromion to be bent down in front of it. The lesion common to both is the injury to other joint structures, particularly the capsular ligament. I have never seen a permanent palsy or crippling of the limb without a subluxation of the shoulder-joint, except in one in which there was some ankylosis and deformity of the elbow, and in that one the functional disturbance was very slight.

The only treatment that I have followed has been to restore the shoulder-joint to as near the normal as possible. Most physicians know something about the difficulties associated with old unreduced dislocations of the shoulder-joint in adults, so that it will not be necessary to emphasize the difficulty of restoring the shoulder-joint to the normal in these children in the presence of a long-standing subluxation, with the acromion and humeral head deformed by the original pressure and by later abnormal growth.

We are only beginning to appreciate the importance of this phase of the subject. To repair the damaged shoulder to the best effect is a large problem. My chief ambition is to be permitted to treat a case with dislocation within a day or two after birth. I have had such a case three weeks after birth, but that was too late for my purpose, as the cicatricial or healing process had been practically completed and reduction of the displacement by non-operative methods was impossible. I have seen two cases five days after birth, but there was no dislocation in either. One had a mild grade of paralysis which completely disappeared in a

few months. The other had a severe grade of paralysis, but this has been slowly disappearing, fast enough to satisfy the parents, and I still have it under observation. In all probability no case with a dislocation of the shoulder has ever recovered a normal arm, although with shoulder treatment they have been very much improved. According to my experience the improvement is largely in proportion to the degree of improvement obtained in the shoulder-joint. Manifestly the best time to correct the deformity there is when the displacement is recent, *i. e.*, at or very soon after birth. How to obtain the best results at this time is still an unexplored field.

CONCLUSIONS. 1. Obstetrical or brachial birth palsy represents only one phase of a much larger shoulder-joint problem. Almost if not all shoulder-joint injuries are associated with a brachial paralysis, palsy or weakness of varying degree and duration. Very rarely will an actual nerve rupture be associated with the paralysis.

2. The best evidence of the absence of such a nerve rupture is the almost uniform and gradual disappearance of the paralysis. This is easily proved in connection with the adult cases, and seems to be true of the obstetrical cases, in which the paralysis is usually of longer duration and more difficult to follow up. If the crippling of the limb persists into adult life it will probably be found in all cases that a posterior dislocation of the shoulder is associated, often with some moderate permanent disturbance in the elbow-joint.

3. In obstetrical paralysis soon after birth there is a profound and almost if not complete paralysis of the whole limb and not a paralysis limited to the small Duchenne-Erb group of muscles. This extensive paralysis is best explained by the inclusion of the branches of the brachial plexus in an axillary inflammation consequent upon a birth injury of the shoulder-joint.

5. The extravasation into the axilla of blood and synovial fluid causes an immediate inflammation and later cicatricial tissue, all of which is probably absorbed in time, thus accounting for the disappearance of the paralysis. Such a pathology has been well established by operative and postmortem findings in the obstetrical and adult cases.

6. The Duchenne-Erb localization of the paralysis by electrical reactions to the deltoid, biceps, brachialis anticus (Duchenne and Erb), infraspinatus (Duchenne) and supinators of the forearm (Erb) has been widely accepted but not corroborated.

7. In his first four cases Duchenne found posterior dislocation of the shoulder which he said occurred at birth and was chiefly responsible for the paralysis. He thought, however, that some of the paralysis was due to injury of the brachial plexus. In four later cases he did not find dislocation of the shoulder in any and attributed the paralysis entirely to injury of the brachial plexus. Since then practically nothing has been said of a shoulder-joint origin, the

dislocations passing unrecognized, and all cases being attributed to injury of the brachial plexus. Since 1911, when the shoulder-joint injury was offered as the primary cause, this theory has made rapid progress.

8. It is very likely that sufficient traction on the head at birth to rupture the brachial plexus has never been applied in a successful delivery.

SIXTH NERVE PARALYSIS OF OTITIC ORIGIN: GRADINEGO'S SYNDROME.¹

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DURING the years of 1916 and 1917 I have had the opportunity of observing 2 cases illustrating this unusual complication of otitis. In the first case the appearance of the ocular paralysis caused considerable apprehension, as I was unfamiliar at the time with the type of case so fully described by Gradinego. The second case, coming a year later, after I had had an opportunity of familiarizing myself with Gradinego's paper, was very interesting, but did not cause the same anxiety on account of the favorable course which he has found usual in these cases. In presenting the two cases I have taken the opportunity of giving a synopsis of the original paper, which I feel will be of interest to any of the members who are not already familiar with it.

In 1904 Gradinego reported² a series of cases in which the three cardinal symptoms, suppurative otitis, severe pain referred to the side of the head, and paralysis of the sixth nerve, were present in combination. There were 5 cases of his own and others collected from literature.

The publication of his paper caused considerable discussion, and there was some doubt expressed as to whether the sixth nerve paralysis was really a complication of the otitis or a coincident symptom from some associated condition, such as suppuration of the sphenoid or an independent cranial nerve palsy.

In 1907 Gradinego³ published a further paper on the subject and collected a series of 57 cases which illustrated his syndrome and established it as a definite clinical type. This syndrome he explains by the hypothesis of a localized meningitis from extension of the middle-ear suppuration through atypical pneumatic cells connected with the region of the Eustachian tube and extending more or less completely to the tip of the pyramid. These cells have been

¹ Presented at the Canadian Medical Association Meeting, Quebec, P. Q., June 26, 1919.

² Arch. f. Ohren., 1904.

³ Ibid., 1907, vol. lxxiv.